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Research Article
Waist Circumference for Central Obesity Detection from the Pre-Elderly Stage to the Elderly Stage in Indonesia: A Longitudinal Study

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Abstract

Background and Objective: Waist circumference is an alternative to determine nutritional status (central obesity) and is an early detector of chronic diseases. This study was conducted to determine whether changes in waist circumference could detect central obesity from the pre-elderly stage to the elderly stage in individuals in Indonesia. **Materials and Methods:** The study followed a longitudinal design using secondary data from the Indonesian Family Life Survey from 2007 and 2014. The population of this study was comprised pre-elderly (53-59 years old) individuals who were observed until they reached their elderly years (60-66 years old). The eligible sample comprised 1324 respondents. **Results:** There was an increase in central obesity prevalence from 42.1% (pre-elderly) to 47.2% (elderly). The prevalence of obesity was 50.4% (pre-elderly-women) to 68.8% (elderly-women); the prevalence of obesity was 33.2% (pre-elderly-men) to 23.9% (elderly-men). Over 7 years, there was an increase of 2.42 cm in the mean waist circumference (men = 1.33 cm, women = 3.43 cm). Changes in body weight, fiber consumption, number of chronic diseases and physical activity were associated with changes in waist circumference ($p<0.05$; $R^2 = 0.64$). **Conclusion:** Changes in waist circumference (central obesity) in the elderly are caused by changes in weight, fiber consumption, number of chronic diseases and physical activity beginning at the pre-elderly stage. Normal weight, high fiber consumption, absence of chronic diseases and physical activity for more than 30 min a day should be maintained beginning in the pre-elderly stage to ensure a normal waist circumference in the elderly stage.

Key words: Elderly, fiber consumption, number of chronic diseases, physical activity, pre-elderly, waist circumference, weight

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Anthropometric measurements are indicators that help determine one's nutritional status. The most well-known and utilized anthropometric assessment is the Body Mass Index (BMI)[1-3]. However, the standard classification system for BMI is less reliable in the elderly population[3,4]. Another measure used to detect the incidence of disease is waist circumference, which is considered more accurate than BMI for detecting non-communicable diseases[5,6].

Waist circumference has been proposed as an alternative to estimate abdominal obesity. Waist circumference is strongly correlated with the amount of abdominal fat and is considered to represent fat stored in the abdomen[7]. Waist circumference can be used as a screening tool for metabolic diseases[8] and for monitoring a patient's diet and amount of exercise[9]. Waist circumference measurements are a very simple, effective and inexpensive method for assessing body fat distribution[10]. The waist circumference for Asians, according to the World Health Organization, is 90 cm for men and 80 cm for women[11].

A waist circumference $\geq$90 cm for men and 80 cm $\geq$80 cm for women is known as central obesity[12]. Obesity is a disease process characterized by excessive accumulation of body fat[6,13]. Obesity is a risk factor for a number of chronic diseases, such as diabetes mellitus, cardiovascular disease and cancer[14]. The cause of obesity is an energy imbalance between the calories consumed and the calories expended[14,15]. One indicator to determine obesity is waist circumference. Waist circumference is actually a slightly better indicator of total body fat and health risk than BMI and is simpler[6].

The results of research related to the nutritional status of the elderly population in America found that 43% of elderly people have a higher nutritional risk[16]. In Chinese adults, the prevalence of obesity ascertained from a combination of BMI, waist circumference and waist to hip ratio measurements was approximately 68.9%[17]. Another study of Chinese adults of a population of 18-96 years old also found that 65.99% of men and 65.97% of women had central obesity[2]. In Indonesia, based on data from the Basic Health Research (Riskesdas) in 2013, the prevalence of central obesity of Indonesian adults was 26.6%[18]. Another study of the elderly population in Indonesia found that 8.4% of elderly people were overweight and 8.8% were obese[19].

Growing older generally increases nutritional risk[19]. Therefore, it is very important to make an early diagnosis of nutritional status, specifically central obesity in pre-elderly individuals, to reduce health risks in the elderly population later on.

The nutritional status of the elderly population should be evaluated at the pre-elderly stage. The nutritional status during the pre-elderly stage must be considered because it will contribute to the nutritional status in the elderly stage. One such indicator of nutritional status is waist circumference.

The purpose of this study was to determine how changes in the waist circumference from the pre-elderly stage to the elderly stage could help improve central obesity detection in Indonesia.

MATERIALS AND METHODS

Study design: The data were collected from secondary data collected by the Indonesian Family Life Survey (IFLS), which was a public domain from IFLS1 (1993) to IFLS5 (2014). IFLS4 (2007) and IFLS5 (2014)data were used in this study. IFLS4 data were collected from November 2007 to April 2008[20], while IFLS5 data were collected from September 2007 to May 2015[21]. This research was performed in 13 elected provinces of Indonesia from IFLS or SAKERTI (Indonesian Life Households Survey), specifically in four provinces in Sumatera (North Sumatera, West Sumatera, South Sumatera and Lampung), five provinces in Java (DKI Jakarta, West Java, Central Java, Yogyakarta and East Java) and four provinces including a group of large islands (Bali, West Nusa Tenggara Barat, South Kalimantan and South Sulawesi). Altogether, these provinces represent approximately 83% of Indonesia[21].

This was a longitudinal study (panel study), which combined cross-sectional and time series study designs. This design was deemed the best way to analyze the changes in waist circumference and other factors that were measured repeatedly over a certain period of time between individuals and between times.

Population and subjects: The population in this study comprised pre-elderly (53-59 years old) individuals at the beginning of the study who were then followed for 7 years until they were 60-66 years old. The pre-elderly stage is a period before entering the elderly stage or before reaching 60 years of age. The pre-elderly age range is 45-59 years[22], while the elderly age range is 60 years old and older[22,23]. Because the study period of IFLS4 and IFLS5 was 7 years, the pre-elderly and elderly age difference in this study was also 7 years. Therefore, the pre-elderly age category was from 53-59 years and the elderly age category was from 60-66 years.

The inclusion of respondent criteria amounted to all data completed from 2007-2014. The number of 1967 pre-elderly individuals from IFLS4 and 1655 respondents from IFLS5 were

interviewed. After data cleaning, there were 1324 respondents (636 men and 688 women) who had similar identifiers as well as waist circumference data. The number of individuals for which there was panel data for two measurement points (pre-elderly and elderly) was 2648 (1272 men, 1376 women).

Measurements: Data were collected from pre-elderly (53-59 years old) individuals in 2007 and elderly (60-66 years old) individuals in 2014 (Book IIIA: COV3). Data were then separated by men and women (Book IIIA: COV5). Anthropometric data were collected by professional nurses[20,21]. The variable measured in this study was waist circumference (dependent variable), which was performed using a tape measure with an accuracy of 0.1 cm[24] (Book US: US06a). The two waist circumference categories were "at risk for central obesity"(men ≥ 90 cm, women ≥ 80 cm) and "not at risk for central obesity"[11].The changes in waist circumference from the pre-elderly stage to the elderly stage were calculated by observing delta values and were categorized into (1) Still at risk, (2) Not at risk of being at risk, (3) Still not at risk and (4) At risk of being not at risk. The independent variables consisted of weight measured by a Camry scale, model EB1003, with an accuracy of 0.1 kg[21] (Book US: US06). Carbohydrate, protein, fat and fiber consumption, which were all substances consumed by the pre-elderly and elderly individuals to fulfill their need for food, were calculated based on the number of meals consumed in the last week with the following categories: never, 1-2, 3-4, 5-6 and 7 times a week (Book IIIB: FM02, FM03). The number of chronic diseases were the number of diseases that were diagnosed in respondents. Smoking behavior was a habit of chewing tobacco or inhaling tobacco by pipe, cigarettes, or a cigar and was measured by the number of cigarettes consumed each day (Book IIIB KM01a, KM04). Physical activity, performed by respondents every day for at least 30 min, was divided into heavy activity, a moderate level of activity and walking and was calculated based on the last 7 days (Book IIIB: KK02m, KK02n, KK02o). Income was the individual salary per year categorized into one of five percentiles (Book IIIA: TK16a).

Statistical analysis: Data analysis included the level of descriptive analysis that was required to obtain the size of the distribution of the mean and standard deviation as well as the size of the frequency for categorical data. Panel data analysis (fixed effect model) was used to determine the association between changes in risk factors and changes in waist circumference. The fixed effect model was a model with different intercepts for each subject (cross-section) but the slope for each subject did not change over time; $p<0.05$ was considered as level of significance.

RESULTS

Overall, the prevalence of central obesity was 42.1% in the pre-elderly stage, which increased to 47.2% in the elderly stage. For the women, the prevalence of central obesity was 50.4% in the pre-elderly stage, which increased to 68.8% in the elderly stage. However, for men, the prevalence of central obesity was 33.2% in the pre-elderly stage, which decreased to 23.9% in the elderly stage (Fig. 1).

Figure 2 shows that the largest change in waist circumference from the pre-elderly stage to the elderly stage

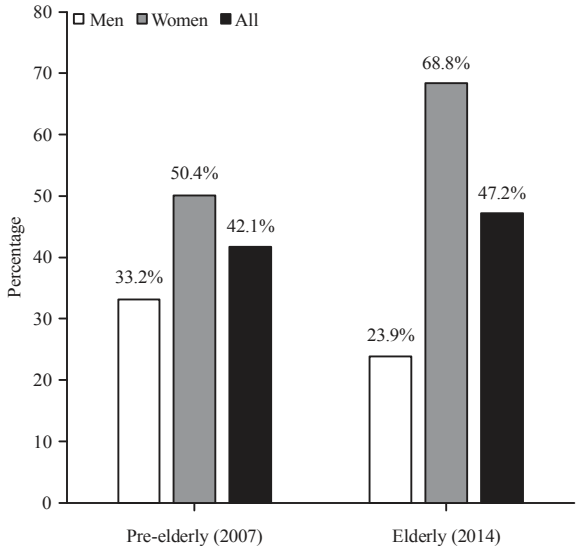

Fig. 1: The prevalence of central obesity in the pre-elderly stage (2007) and the elderly stage (2014)

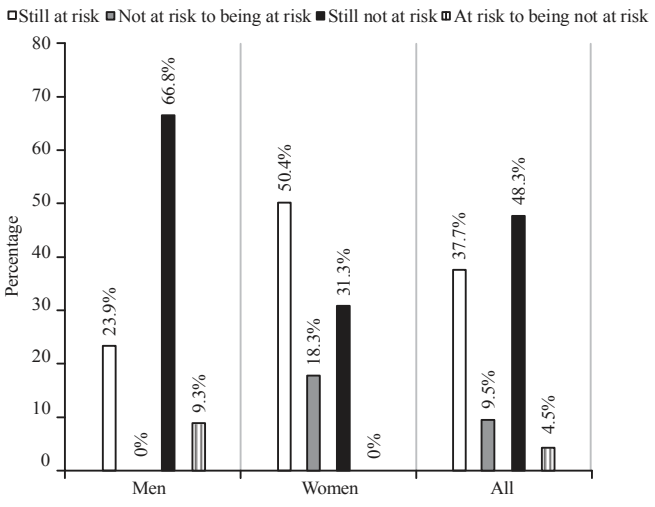

Fig. 2: Changes in waist circumference from the pre-elderly stage (2007) to the elderly stage (2014)

was the category of "still not at risk" (48.3%). The most common category for men was "still not at risk" (66.8%), while the most common category for women was "at risk" (50.4%).

This study demonstrated that the average waist circumference in the pre-elderly stage was 81.87±11.56 cm, which then increased to 84.29±12.43 cm in the elderly stage. The average waist circumference of men was 80.76±10.30 cm in the pre-elderly stage, increasing to 82.09±11.21 cm in the elderly stage. The average waist circumference of women was 82.91±12.53 cm in the pre-elderly stage, increasing to 86.34±13.14 cm in the elderly stage (Table 1).

The average independent variables, such as weight, carbohydrate consumption, protein consumption, fat consumption, fiber consumption, physical activity and income, decreased from the pre-elderly stage to the elderly stage. However, the average number of chronic diseases and smoking behavior increased from the pre-elderly stage to the elderly stage (Table 1).

The results of the panel data analysis for the 7-year observation indicated that four variables (weight, number of chronic diseases, fiber consumption and physical activity) were significantly associated with waist circumference ($p<0.05$), while five variables (carbohydrate consumption, protein consumption, fat consumption, smoking behavior and income) were not significantly associated with waist circumference ($p>0.05$). There were 2648 observations of 1324 respondents and the R Square (R^2) value was 0.64. This means that 64% of the changes in waist circumference could be explained by the factors of weight, fiber consumption, number of chronic diseases and level of physical activity. The other 36% was explained by other factors not included in this study (Table 2).

Multivariate results with the fixed effect model indicated that changes in weight, fiber consumption, number of chronic diseases and physical activity are associated with changes in waist circumference. The model showed that the changes in weight and the number of chronic diseases were positively associated with changes in waist circumference. An increase in one unit of weight (1 kg) resulted in an increase in waist circumference by 0.7 cm, while each unit of increase of chronic

Table 1: Characteristics of the respondents in the pre-elderly stage (2007) and the elderly stage (2014)

	Mean±SD					
	Men (n = 636)		Women (n = 688)		All (n = 1324)	
Variables	Pre-elderly	Elderly	Pre-elderly	Elderly	Pre-elderly	Elderly
Waist circumference (cm)	80.76±10.10	82.09±11.21	82.91±12.53	86.34±13.14	81.87±11.56	84.29±12.43
Weight (kg)	57.12±10.18	56.62±10.51	52.96±11.54	52.89±11.60	54.96±11.10	54.69±11.24
Number of chronic diseases	0.43±0.71	0.81±1.11	0.64±0.91	0.97±1.10	0.54±0.83	0.89±1.11
Carbohydrate consumption (days/week)	5.00±0.12	4.99±0.11	5.00±0.08	4.97±0.28	5.00±0.10	4.98±0.21
Protein consumption (days/week)	3.84±1.00	3.69±1.20	3.86±1.04	3.56±1.23	3.85±1.02	3.62±1.22
Fat consumption (days/week)	1.98±1.45	1.77±1.35	1.84±1.39	1.77±1.39	1.91±1.42	1.77±1.37
Fiber consumption (days/week)	3.69±0.71	3.21±1.03	3.69±0.82	3.16±1.08	3.69±0.77	3.18±1.06
Physical activity (total activities/week)	21.71±11.73	13.61±9.96	17.33±10.00	11.59±9.15	19.43±11.08	12.56±9.59
Smoking behavior (total cigarettes/day)	8.72±8.67	9.41±9.95	0.25±2.00	0.39±2.23	4.32±7.48	4.72±8.39
Income (percentile)	3.80±1.24	3.37±1.31	2.39±1.47	2.31±1.37	3.07±1.54	2.82±1.44

SD: Standard deviation

Table 2: Fixed effect model of the association of changes in risk factors with changes in waist circumference (n = 2648)

				95% CI	
Waist circumference	β	SE	p-value	Lower	Upper
Weight (kg)	0.704	0.041	<0.001	0.625	0.784
Number of chronic diseases	0.566	0.191	0.003	0.191	0.941
Carbohydrate consumption (days/week)	-1.125	0.890	0.207	-2.873	0.622
Protein consumption (days/week)	-0.274	0.161	0.089	-0.591	0.042
Fat consumption (days/week)	-0.167	0.127	0.187	-0.415	0.081
Fiber consumption (days/week)	-0.770	0.175	<0.001	-1.114	-0.426
Physical activity (total activities/week)	-0.058	0.014	<0.001	-0.086	-0.030
Smoking behavior (total cigarettes/day)	-0.013	0.032	0.673	-0.077	0.050
Income (percentile)	0.040	0.131	0.760	-0.218	0.298
Constant	54.525	4.911	<0.001	44.891	64.161

R Square = 0.64, Prob>F = 0.0000, SE: Standard error, CI: Confidence interval

disease was shown to increase waist circumference by 0.6 cm. Changes in fiber consumption and physical activity were negatively associated with changes in waist circumference. This means that an increase of one unit of fiber consumption and physical activity would decrease the waist circumference by 0.8 and 0.1 cm (Table 2).

DISCUSSION

In this study, the prevalence of central obesity in the pre-elderly stage increased to 5.1% in the elderly stage. Central obesity was determined based on waist circumference. The determining factors associated with changes in waist circumference in the elderly population in Indonesia were changes in weight, fiber consumption, number of chronic diseases and physical activity from the pre-elderly stage to the elderly stage.

The prevalence of central obesity increased, especially in elderly women. The high prevalence of central obesity in women is because, physiologically, women have a higher body fat percentage and higher overall weight than men and experience a reduction in height, which occurs earlier and is more drastic than in men[25]. A previous study conducted on elderly Chinese populations also found that the prevalence of overweight and obesity was 70%. Aging plays an important role in the prevalence of overweight and obesity[17]. Research in North Africa showed that obesity rates in women were three times greater than those in men (24.32% compared to 7.69%)[26].

Based on the changes over 7 years, the average waist circumference from the pre-elderly stage to the elderly stage increased slightly (2.42 cm [1.33 cm for men, 3.43 cm for women]). The average waist circumference was 81.87 cm in the pre-elderly stage, increasing to 84.29 cm in the elderly stage. This was the same observation as that of a 7-year longitudinal study of an elderly population in China in which waist circumference increased by 1.4 cm, from 82.9 cm in 2004 to 84.3 cm in 2011[17].

From the research data, it was observed that men experienced an increase in waist circumference from the pre-elderly stage to the elderly stage but remained in the normal range (waist circumference <90 cm), whereas women from the pre-elderly stage to the elderly stage exhibited central obesity (waist circumference ≥80 cm). This was caused by increases in waist circumference with age[4,5].

One of the changes in waist circumference is caused by changes in weight. Weight decreased longitudinally in the elderly population. The prevalence of being overweight increases with age in developed countries for both men and women (greater in women) but weight measurements tend to show weight loss in those aged 55 years or older[4]. In accordance with the results of this study, weight loss with increasing age occurred from the pre-elderly stage to the elderly stage, although the average decrease in weight was not very large (0.3 kg).

Being overweight could cause obesity. Obesity affects the occurrence and incidence of chronic diseases[27]. Patients with a normal weight have a balanced life[26]. To maintain a normal weight, you need to consume a healthier diet. A component of a healthy diet is high fiber consumption. Fiber intake plays a protective role in the incidence of obesity. High fiber foods could reduce weight and obesity[28].

Fiber is defined as a part of plant foods that are resistant to digestion by human digestive enzymes. Fibers are classified as soluble fibers, such as thickened fiber, which is fermented in the colon and insoluble fibers, such as wheat fiber, which can only be fermented to a certain extent in the colon. The intake of dietary fiber provides many health benefits, such as reducing the risk of coronary heart disease, stroke, hypertension, diabetes, obesity and digestive disorders. Increasing fiber consumption could decrease serum lipid concentrations, reduce blood pressure, help with weight loss and improve immune function[29].

The results showed that changes in fiber consumption were associated with changes in waist circumference, which led to a decrease in central obesity. This negative correlation means that a decrease in fiber consumption could cause an increase in waist circumference in elderly populations. This finding is supported by studies in five European countries (5.5 years of follow-up), which found that fiber consumption in women was negatively correlated with an increase in waist circumference[30].

The reporting of fiber consumption in this study did not investigate how many nutrients were consumed but did identify how many days per week respondents consumed predetermined food substances. Despite this, information on food consumption was very useful in analyzing the changes that occurred.

Changes in the number of chronic diseases also caused an increase in the incidence of obesity, while aging caused an increase in chronic diseases. These diseases could affect appetite, functional ability, or swallowing ability, which lead to a decrease in nutritional status[31]. However, in this study, changes in the number of chronic diseases were associated

with changes in waist circumference. The presence of a positive relationship means that there was an increase in waist circumference as the number of diseases increased. The results showed that there was an increase in the number of diseases suffering from the pre-elderly stage to the elderly stage. Increased disease was also accompanied by an increase in overall waist circumference. When viewing the data on the number of illnesses, it is demonstrated that the average elderly individual suffered from one chronic disease. In the United States in 2016, approximately 80% of elderly people aged ≥65 years had at least one chronic condition, while 60% had two or more chronic conditions[31].

The changes in physical activity was related to changes in waist circumference. Properly regimented physical activity affects the waist circumference[32]. In this study, changes in physical activity from the pre-elderly stage to the elderly stage were associated with a reduction in waist circumference. Physical activity reduced waist circumference by 0.1 cm. Physical activity, in the form of heavy activity, moderate activity and walking activities should be performed for at least 30 min a day.

Likewise, increasing access to local physical activity facilities could increase physical activity and has the potential to reduce overweight and obesity at the population level. Additionally, reducing access to fast food would help. Populations with access to six or more physical activity facilities had waist circumferences that were 1.22 cm smaller than those who did not have access to facilities of physical activity[32].

Physical activity positively affects chronic diseases and conditions and increases physical fitness and physical functions that could improve the quality of life of the elderly. Most chronic diseases and conditions negatively affected the functional abilities of the elderly individuals while also impacting their quality of life. Physical activity was beneficial for several chronic diseases and conditions. For example, physical activity expended energy (obesity), increased insulin sensitivity (type 2 diabetes mellitus), improved the lipid profile (cardiovascular disease), increased muscle strength (physical function), benefited psychological well-being (depression) and ultimately improved quality of life[33]. Increased weight, decreased fiber consumption, increased number of chronic diseases suffered and lack of physical activity can lead to increased waist circumference in elderly populations. If this increase in waist circumference was unchecked, it would have an impact on central obesity. Central obesity in the elderly can be detected by looking at the increase in waist circumference from the pre-elderly stage to the elderly stage. The increase was due to factors such as weight, fiber consumption, number of chronic diseases and physical activity.

CONCLUSION

Changes in waist circumference from the pre-elderly stage to the elderly stage are caused by changes in weight, fiber consumption, number of chronic diseases and physical activity. Changes in these determining factors can help us detect central obesity in elderly populations. If this determining factor is not considered, there will be an increase in waist circumference. The increase in waist circumference results in central obesity.

For elderly individuals to maintain a normal waist circumference and not suffer from central obesity, it is necessary to maintain a normal weight by maintaining high fiber consumption patterns, performing physical activity for at least 30 min every day and maintaining a healthy lifestyle to avoid chronic diseases beginning with the pre-elderly stage.

SIGNIFICANCE STATEMENT

This study discovered risk factors for changing waist circumference or central obesity from the pre-elderly stage to the elderly stage. Understanding these risk factors can be beneficial for preventing central obesity in the elderly. This study will help researchers uncover the critical areas of changes in waist circumference that many researchers were not able to explore. Thus, a new theory on central obesity may be developed.

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